Phase Locked Loop Design

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Engineering 315

Introduction

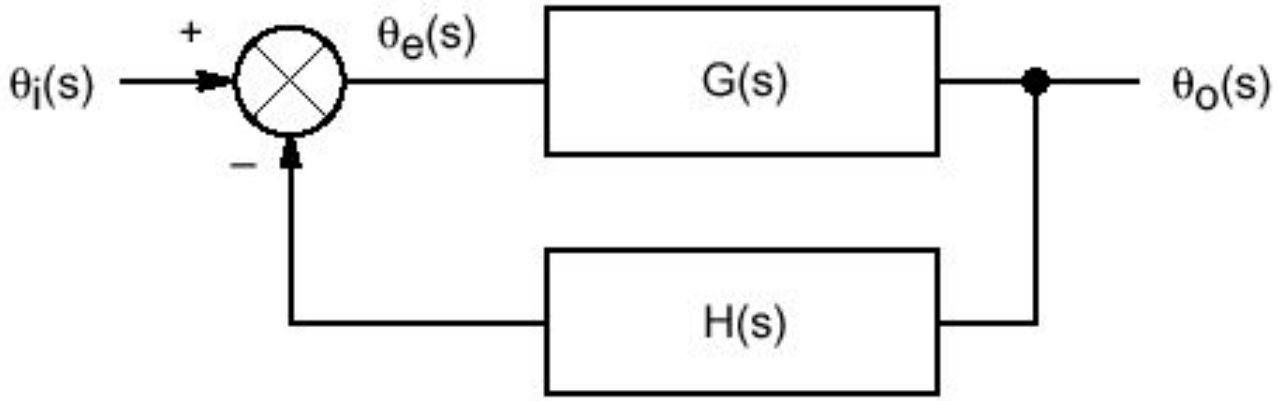
- What is a PLL?
- Control System Representation
- Parts of a PLL
- PLL in Simulink

What is a PLL?

- Digital frequency control system
  - Generate high speed oscillations
  - Acquire and track signals
    - Radio Frequency Demodulation
    - DX-ing
    - RF communications

Control system representation

Feedback System



$\theta_i(s)$	Phase Input
$\theta_e(s)$	Phase Error
$\theta_o(s)$	Output Phase
G(s)	Product of the Individual Feed Forward Transfer Functions
H(s)	Product of the Individual Feedback Transfer Functions

Modeling a PLL

Representing a Phase Locked Loop as a transfer function

System sensitivity:

$$\frac{\theta_e(s)}{\theta_i(s)} = \frac{1}{1 + G(s) \cdot H(s)}$$

Where:

$\theta_i(s)$ = Phase input

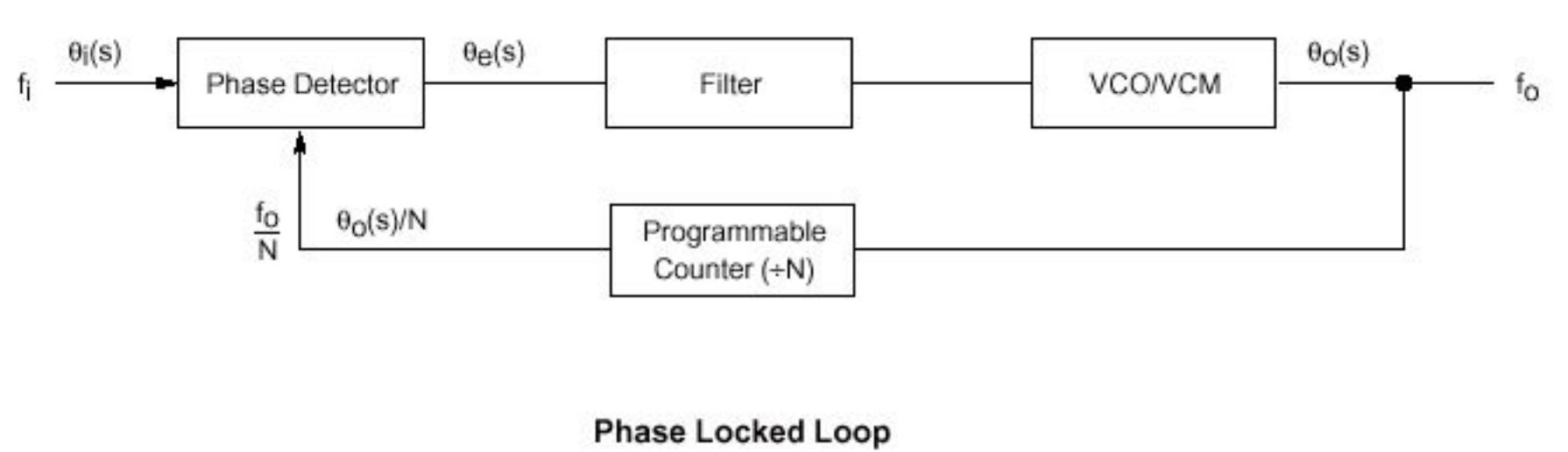
$\theta_o(s)$ = Output phase

$\theta_e(s)$ = Phase error

Closed loop transfer function:

$$\frac{\theta_o(s)}{\theta_i(s)} = \frac{G(s)}{1 + G(s) \cdot H(s)}$$

PLL Control System



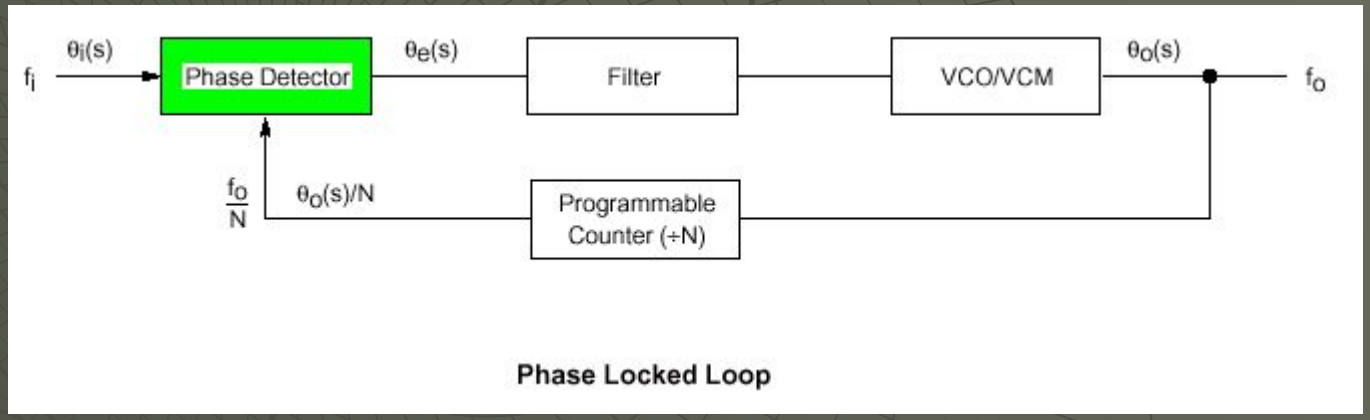
Phase Locked Loop

Parts of a PLL

- Phase Detector
- Filter
- Voltage Controlled Oscillator
- Programmable Counter

Parts of a PLL

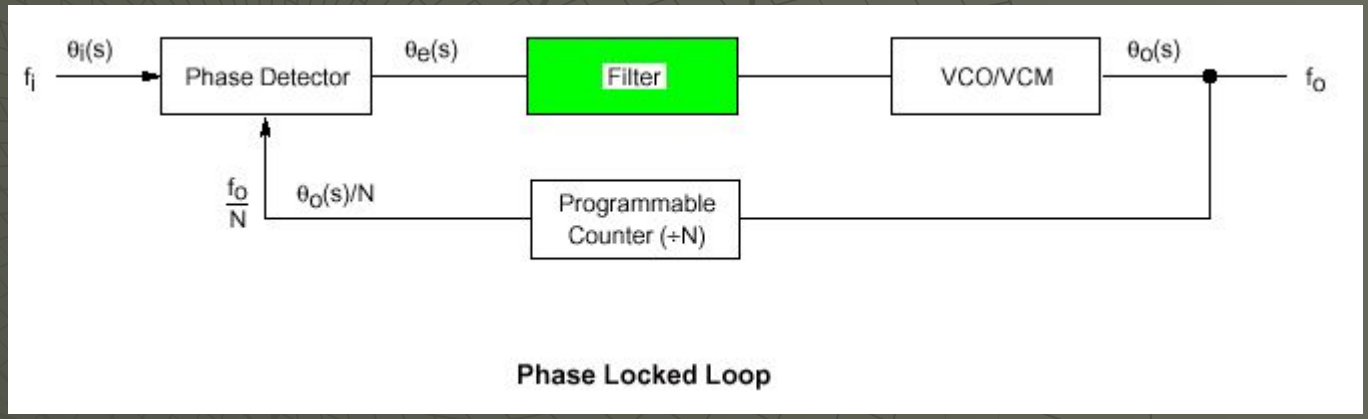
- Phase Detector
  - Acts as comparitor
  - Produces a voltage proportional to the phase difference between input and output signal
  - Voltage becomes a control signal



Phase Locked Loop

Parts of a PLL

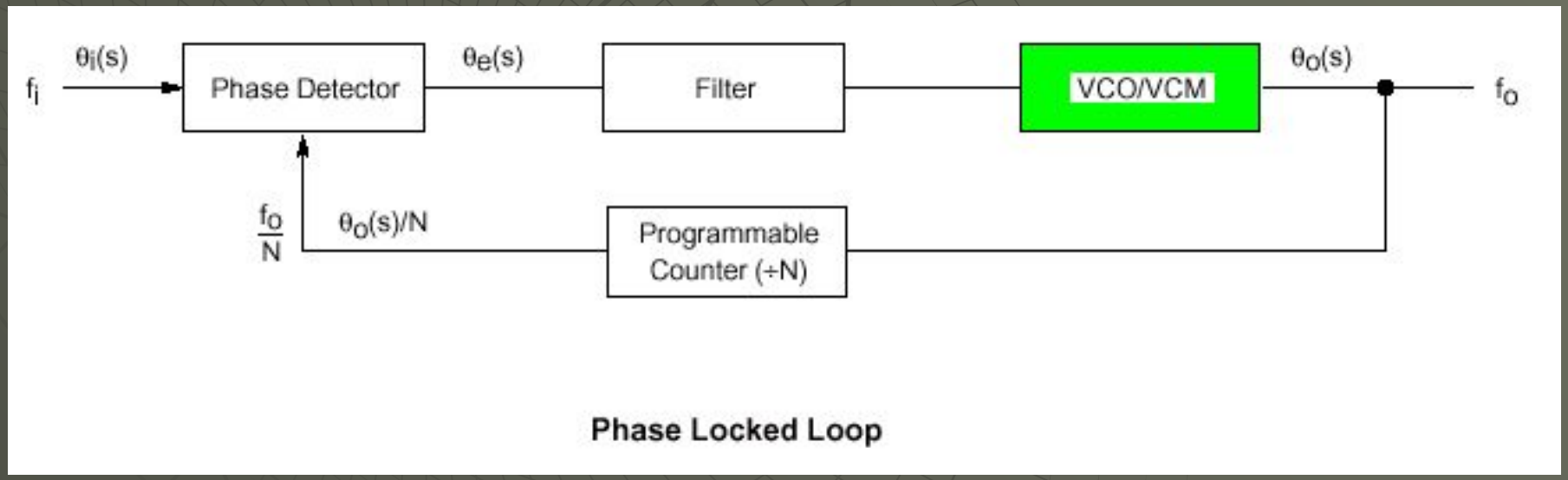
- Filter
  - Determines dynamic characteristics of PLL
    - Specify Capture Range (bandwidth)
    - Specify Tracking Range
  - Receives signal from Phase Detector and filters accordingly



Phase Locked Loop

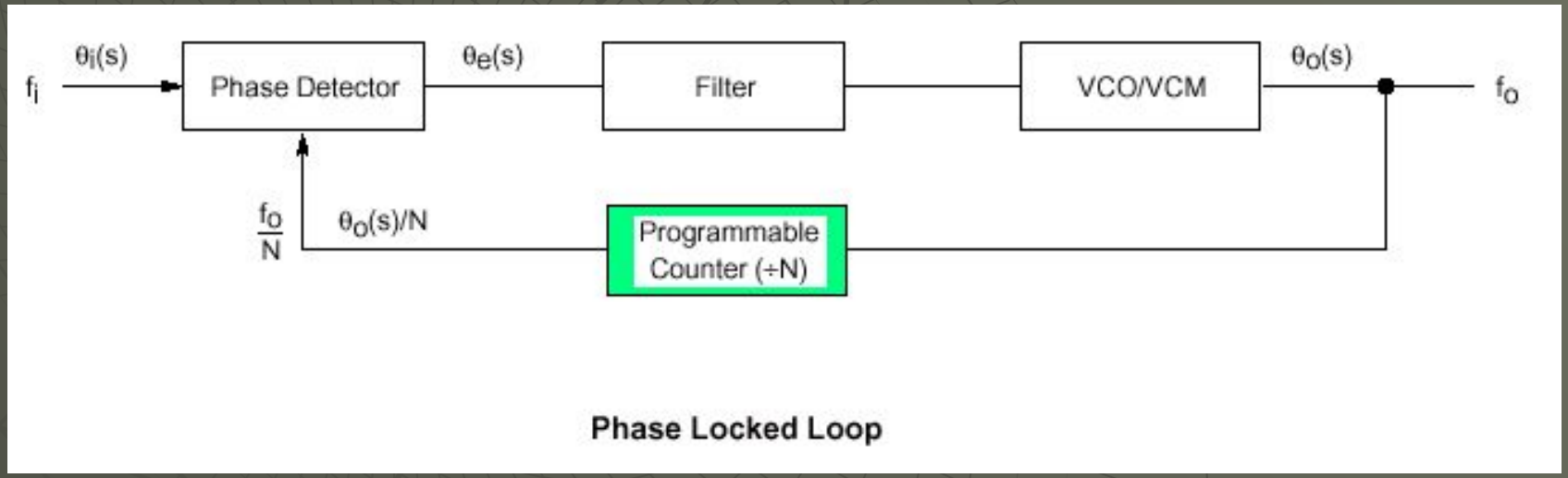
Parts of a PLL

- Voltage Controlled Oscillator
  - Set tuning range
  - Set noise margin
  - Creates low noise clock oscillation



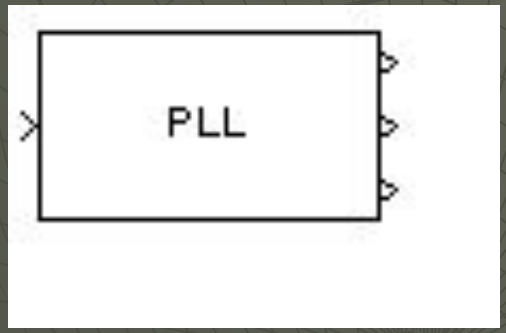
Parts of a PLL

- Divider
  - Divides the VCO output by the degree of the open loop gain
  - Feedback loop allows phase comparison



Phase Locked Loop

PLL in Simulink



Block Parameters: Charge Pump PLL

Charge Pump PLL (mask)

Implement a charge pump phase-locked loop using a digital phase detector. The three outputs are the outputs of the lowpass filter, the phase detector, and the voltage controlled oscillator (VCO). The input must be a sample-based scalar signal.

Parameters

Lowpass filter numerator:

[3.0002 0 40002]

Lowpass filter denominator:

[1 67.46 2270.9 40002]

VCO input sensitivity (Hz/V):

1

VCO quiescent frequency (Hz):

100

VCO initial phase (rad):

0

VCO output amplitude:

1

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Questions?